Heat-Pump Water Heaters: Reliable, Efficient

The Problem

About 10 percent of California residents use conventional electric water heating—a technology that's expensive to operate and contributes to peak demand. Heat-pump water heaters (HPWHs) are an efficient alternative, consuming less than half as much electricity as their conventional cousins. However, products available to date have been expensive to manufacture, install, and maintain.

The Solution

The Watter$aver heat-pump water heater (**Figure 1**), developed by TIAX LLC in conjunction with manufacturer EnviroMaster International (EMI), has a shorter installation time than other HPWHs and offers the same life expectancy as a standard electric resistance heater. The Watter$aver is now available as a commercial product from EMI. Laboratory and field tests have confirmed its high performance (**Table 1**) and reliability.

TIAX has field-tested 20 of its 50-gallon Watter$avers in different California climate zones, installing those units in different areas within the home (garage, basement, or laundry room) and in homes with different numbers of occupants and varying degrees of water hardness. Oak Ridge National Laboratory also tested 10 units in the lab and found the estimated life expectancy for these HPWHs to be about 11 years, whereas standard electric units last between 11 and 14 years. The payback on the incremental cost of the Watter$aver as compared with a conventional electric unit is about 5 to 8 years.

Table 1: Watter$aver's energy savings

The Watter$aver represents a significant advance over traditional 50-gallon water heaters. Energy factor is defined as the energy supplied in heated water divided by the energy input to the water heater.

Performance factor	Watter$aver	High-efficiency electric resistance	Standard efficiency
Energy factor	2.48	0.94 to 0.95	0.88
Energy savings per year relative to standard unit (%)	30 to 50	~8	NA

Note: NA = not applicable.

Figure 1: The Watter$aver heat-pump water heater

The Watter$aver product pictured here consumes 30 to 50 percent less energy than a conventional electric resistance water heater.

Features and Benefits

The main features of the Watter$aver are embodied in its redesigned components, which include:

- A compressor that operates on 120 volts AC (VAC) power instead of 240 VAC.
- A low-cost condenser manufactured with thermal mastic—a putty-like substance with good heat-transfer characteristics—instead of solder.
- Two fixed-speed evaporator fans that provide more flexibility than a single fan at less cost than a variable-speed fan.
- A backup electric-resistance-mode heating element.

The heat-pump water heater provides the following benefits as compared with conventional units:

- Reduced demand. The electric demand of HPWHs is 60 to 70 percent lower than for electric resistance water heaters (**Table 2**, page 2). The heating is distributed over a longer period of time at a lower power draw.
- *Electricity savings*. Participants in TIAX's HPWH tests saved between 28 and 52 percent on their electric bills.

Table 2: HPWH lowers electric demand

Researchers at the Oak Ridge National Laboratory found significant decreases in electric demand when they measured demand for six Watter$aver heat-pump water heaters for six-week periods in summer and winter and compared the results with measurements for the same water heaters operating in electric resistance mode.

	Demand (kilowatts)			
	Winter morning peak	Winter evening peak	Summer morning peak	Summer evening peak
Electric resistance mode	2.6	1.6	2.1	1.0
Heat-pump water heater	1.0	0.7	0.6	0.3
Demand reduction (%)	**62.0**	**56.0**	**71.0**	**70.0**

- *Dehumidification and space conditioning.* The HPWH evaporator removes moisture from the environment, providing dehumidification and cooling in addition to hot water when it is installed in conditioned space.

Surveys of those who participated in the field tests showed that they liked the new design. The most popular features were energy and cost savings, dehumidification capabilities, and the ability of the unit to remove odors. However, compressor noise may be a problem when the HPWH is installed near high-occupancy areas.

Applications

At its current cost, the residential HPWH is economically viable for California households that use electric water heating and consume more than 64 gallons of hot water per day. Households with four or more occupants typically achieve that level of consumption.

California Codes and Standards

In California, Title 24 building energy standards encourage gas water heaters in residential new construction. However, in areas where natural gas is not available, the Watter$aver can help builders meet the energy-efficiency requirements of Title 24. The Watter$aver is also a viable option for replacing existing electric water heaters.

What's Next

EMI, the manufacturer of the Watter$aver, continues to market and sell the product. Consumers can purchase the Watter$aver for $1,500 to $1,800 installed, or contractors can purchase it for $1,000 to $1,200 from distributors. EMI hopes to work with utilities and other organizations to provide incentives for Watter$aver purchases and installation.

For HPWHs to significantly penetrate the market, manufacturers will have to figure out how to reduce the cost per unit. One solution would be to achieve higher production volumes, but another option would be to reduce installation time and effort. Only one person is needed to install a conventional water heater, but two people are needed to cope with the Watter$aver's height and weight.

EMI is working on several technical improvements to the Watter$aver, including making it lighter and incorporating better controls. Overcoming the cost issue and ensuring that the HPWH is reliable will likely lead to an optimized product.

Collaborators

The organizations involved in this project include TIAX LLC, EnviroMaster International, and the Oak Ridge National Laboratory.

For More Information

Reports documenting this project and providing more details can be downloaded from the web at www.energy.ca.gov/pier/final_project_reports/500-04-018.html.

Visit www.ecrinternational.com for more information about the Watter$aver.

To view Technical Briefs on other topics, visit www.esource.com/public/products/cec_form.asp.

Contacts

EMI, Karl Mayer, karlm@ecrinternational.com

TIAX LLC, Bob Zogg, zogg.r@tiax.biz

California Energy Commission, Nancy Jenkins, njenkins@energy.state.ca.us or visit www.energy.ca.gov/pier/buildings

About PIER

This project was conducted by the California Energy Commission's Public Interest Energy Research (PIER) program. PIER supports public-interest energy research and development that helps improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

Arnold Schwarzenegger, *Governor*

For more information see www.energy.ca.gov/pier

California Energy Commission *Chair* Joe Desmond, *Vice Chair* Jackalyne Pfannenstiel
Commissioners: Arthur H. Rosenfeld, James D. Boyd, John L. Geesman

CEC-500-2005-100-FS
052505